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INCIDENCE OF LYMPHOID AND MYELOID LEUKEMIA IN U.S. ACTIVE-DUTY MILITARY MEN ACCORDING TO OCCUPATION, AND COMPARISONS WITH INCIDENCE FROM THE U.S. SURVEILLANCE EPIDEMIOLOGY AND END RESULTS (SEER) POPULATIONS

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Incidence of Lymphoid and Myeloid Leukemia in U.S. Active-Duty Military Men According to Occupation, and Comparisons with Incidence from the U. S. Surveillance, Epidemiology and End Results (SEER) Population

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Abstract

This historical prospective study determined incidence rates, based on first hospitalizations, of lymphoid, myeloid, and all leukemias among military men serving on active duty between 1 January 1989 and 31 December 1999. Standardized incidence ratios (SIRs) were calculated to determine if incidence of leukemia in military men differed from incidence rates in the nine-area United States Surveillance, Epidemiology and End Results (SEER) civilian population. Military occupations were grouped into 35 categories according to likelihood of similar exposures and age-specific person-years were calculated for each occupational group. There were a total of 16,262,855 person-years at risk in active-duty men over the 132-month study period with N = 353 first hospitalizations for leukemia (ICD-9 Codes 204-208), including N = 123 for lymphoid leukemia (ICD-9 Code 204) and N = 164 for myeloid leukemia (ICD-9 Code 205). Overall, leukemia incidence rates were significantly lower in the active-duty population in comparison to the SEER population (SIR = 0.64, 95% C.I. 0.58-0.68). This was true for both lymphoid (SIR = 0.73, 95% C.I. 0.61-0.87) and myeloid (SIR = 0.53, 95% CI 0.45-0.61) leukemia. SIRs based on SEER and the DoD standard populations revealed no occupational group at statistically significantly elevated risk for lymphoid, myeloid or all leukemias. Non-statistically significantly elevated SIRs for all leukemia among woodworkers (2 cases, DoD SIR = 7.27, 95% CI = 0.88-26.26), construction workers (8 cases, DoD SIR = 1.34, 95% CI = 0.58-2.64), and radar operators (6 cases, DoD SIR = 1.90, 95% CI = 0.70-4.15) might warrant further surveillance of these groups in the future.

Key words: Leukemia, occupational studies, military populations, cancer, epidemiology.

List of Acronyms

Acronyms	Definition
CI	Confidence Interval
DEERS	Defense Enrollment Eligibility Reporting System
DMDC	Defense Manpower Data Center
EI/DS	Executive Information/Data System
ICD-9	International Classification of Disease
OR	Odds Ratio
PMRs	Proportional Mortality Ratios
SEER	Surveillance Epidemiology and End Results
SIDR	Standard Inpatient Data Record
SIR	Standardized Incidence Ratio

Introduction

A total of 30 800 new cases and 21 700 deaths from leukemia are expected to occur in the United States during 2002 (1). For all ages combined, the most common type of leukemia is myeloid, followed by lymphocytic and other leukemias. Lymphocytic leukemia is the main type afflicting children, while myeloid leukemia is the most common cell type in adult cases. Leukemia is the second leading cause of death in children, after accidents, despite a decline in recent years in the mortality rate of childhood leukemia (1). Age-adjusted leukemia death rates have remained stable at approximately 10 per 100 000 population per year since approximately 1960 (1).

Predominant etiological concerns have been exposures to solvents containing benzene, other industrial chemicals, pesticides, and exposure to electromagnetic fields (2-13). No temporal periodicity of incidence rates has been reported, as might be expected for an infectious disease. Owing to its relative rarity, few cohort studies have been conducted of leukemia. Most of the existing research consists of case-control or cross-sectional studies, with relatively few prospective, population-based studies.

A case-control study of 513 leukemia cases and 1 087 controls reported increased risk of leukemia among nursing and healthcare workers, farmers, janitors, cleaners, and truck drivers, and observed suggestive increased risks in printers, painters, and metal workers, although these were not statistically significant (2). A cross-sectional study in Ireland reported high a prevalence rate of leukemia in farmers (3).

An historical cohort study in Sweden reported that petroleum refinery workers had a Standardized incidence ratio (SIR) of 3.5 (95% Comparison incidence (CI), 1.5 - 7.0) for leukemia, and attributed the excess risk to benzene exposure (4). A study of refinery workers and a comparison population in California reported a statistically significantly lower risk of leukemia in the refinery workers than in the general population, possibly due to a healthy worker effect (5). By contrast, a cross-sectional study in Denmark reported no association between childhood residence in areas with high

ambient concentrations of benzene and prevalence of leukemia (6). Reported associations of benzene with leukemia have mainly been associations with myeloid or other leukemias, rather than lymphocytic leukemia (7).

A case-control study in Italy reported higher than average risks of leukemia in metal processors, material handlers, rubber workers, and painters (8). A case-control study in New Zealand reported an odds ratio of 1.9, 95% (CI, 1.0 to 3.8) for acute leukemia in persons who ever worked in an electrical occupation (9). The risks were highest among welders (Odds Ratio (OR) = 2.8, 95% CI, 1.2 to 6.8) and telephone line workers (OR = 5.8, 95% CI, 1.2 to 27.8). The risk was dose-related and was confined to nonlymphocytic leukemia.

Since leukemia is a highly fatal disease in adults, a considerable number of occupational studies have been based on mortality. Most have used proportional mortality ratios (PMRs), which are uncertain measures of association that are subject to bias. Such studies have reported excessive percentages of deaths from leukemia in electrical workers (10), myeloid leukemia in clinical laboratory technicians (11), and leukemia in farmers (12). Airline pilots were reported to have PMRs similar to individuals in other occupations (13). Proportionate studies are very limited in their usefulness because they report percentages of deaths from leukemia rather than rates. Increased or decreased death rates from causes other than leukemia in an occupational group can artifactually change percentage of deaths attributed to a single cause, such as leukemia.

This study was performed to determine incidence rates, based on first hospitalizations, of lymphoid, myeloid, and all leukemias combined in active-duty military men according to occupational group. The study also was designed to provide comparisons of age-specific and age-adjusted hospitalized incidence rates of leukemia in the Department of Defense active-duty population with incidence rates in the 9-area United States Surveillance, Epidemiology and End Results (SEER) civilian population (14). This research is devoted to advancing the primary goal of the DoD Operational

Medicine Research Program, which is to develop strategies to protect and sustain service members and ensure that they remain in good health (15,16). The study was designed to determine if there were any occupational groups with unexpectedly high incidence rates of lymphoid, myeloid, or all leukemias combined among military men serving on active duty between 1 January 1989 and 31 December 1999.

Methods

The study used an historical prospective design. Demographic and service-related information for the study population were obtained from the Defense Manpower Data Center (DMDC) in Monterey, California in the form of data tapes for all service members who were on active duty at any time during each of the 132 months of this study. Monthly records are maintained by DMDC using reports submitted by each service. DMDC is the definitive source for monthly denominator data on military populations. This study includes officers and enlisted personnel from the U.S. Army, Navy, Air Force, and Marine Corps. Lymphoid, myeloid, and all types of leukemia were identified using the Standard Inpatient Data Record (SIDR) inpatient database of admissions to DoD medical treatment facilities maintained by the Department of Defense Executive Information/Data System (EI/DS)(17). Hospitalizations of active-duty service members in military medical treatment facilities worldwide are reported to the EI/DS. Exceptions are admissions solely to wartime portable field hospitals or emergency medical facilities located aboard aircraft carriers or amphibious ships. Diagnoses were coded in the SIDR according to the International Classification of Diseases ninth revision (ICD-9).

Admission of any active-duty man with a diagnosis of leukemia (ICD-9 Codes 204 to 208) in any position among the first 8 diagnoses in the hospital discharge summary were extracted from records provided by EI/DS. The records were sorted according to social security number and hospital admission date, and the first recorded admission for leukemia in an individual was extracted for further analysis. Records of cases were then matched to records of demographic characteristics of all active-duty military personnel from the DMDC. A consolidated file was created that merged data

from the SIDR and demographic data from DMDC. The DMDC demographic records provided information on the occupation of each service member. Occupations were aggregated in advance of performing the analyses into 35 groups with shared likelihood of similar exposures. A detailed table showing specific occupations comprising each group is provided in Appendix A.

Statistical Analysis

Incidence (first hospitalization) rates for lymphoid leukemia (ICD-9 Code 204), myeloid leukemia (ICD-9 Code 205) and all leukemia (ICD-9 Codes 204 to 208) were calculated for each of 35 occupational groups. Age-specific rates per 100 000 person-years were calculated by dividing the number of first hospitalizations in each 5-year age stratum by person-years denominators for the age stratum and multiplying by 100 000. Risks in different occupations were compared to the entire DoD population and the SEER population using standardized incidence ratios. The SIRs were based on overall rates of lymphoid, myeloid, and all types of leukemia in active-duty men in the same sex and race group in the entire Department of Defense during 1989 to 1999, and on age-specific incidence rates of each type of leukemia in the SEER population for 9 areas of the United States. Ninety-five percent confidence intervals were calculated using the Poisson distribution (18).

The Defense Enrollment Eligibility Reporting System (DEERS) was used to verify service history data. DEERS is the official military employment database that is used to determine medical benefits eligibility, insurance, immunizations, and other medical information on active-duty Department of Defense service members.

Age-specific incidence rates in men in the U.S. general population were obtained from the SEER Cancer Statistics Review of the National Cancer Institute (NCI) Surveillance, Epidemiology and End Results (SEER) Program through the NCI Web site (19). The time period available for SEER rates was 1989 to 1999, which was identical to the time period for ascertainment of DoD cases. SEER rates were multiplied by the

number of active-duty person-years in each 5-year age stratum to obtain expected numbers of events. Expected numbers were summed across strata, and SIRs were calculated as the ratio of number of observed to expected first hospitalizations. Several of the above data sources and similar methods have been used to carry out previous epidemiological studies among active-duty Navy service members (20-27).

Results

There were 16 262 855 person-years at risk among active-duty men in this study during 1989 to 1999 (Table 1). The number of first hospitalizations (incident cases) for all types of leukemia, age-specific rates per 100 000 person-years, and SIRs based on comparison with the SEER population also are shown in Table 1. Overall, leukemia incidence rates were significantly lower in the active-duty population than in the SEER population (SIR = 0.64). Incidence rates among active-duty service members rose exponentially with age among white men through age 55 to 59 years. Rates were similar among black men and white men through age 45 to 49 years; no cases were diagnosed among older black men. Rates among men of other races were much lower than among white men through age 40 to 44; no cases were diagnosed among older men of other races. Incidence rates among DoD men were not significantly different from those of men of the same race in the SEER population in any age group.

The number of cases of lymphoid leukemia, incidence rates, and SIRs are shown in Table 2. For men of all races combined, incidence rates of lymphoid leukemia were lower in the active-duty population than in the SEER population (SIR = 0.73). Incidence rates of lymphoid leukemia among black men and men of other races were similar to those among men in the same racial groups in the SEER population.

The number of cases of myeloid leukemia, incidence rates, and SIRs are shown in Table 3. For men of all races, the incidence rate of myeloid leukemia also was lower in the active-duty population than in the SEER population (SIR = 0.53)(Table 3). Rates among DoD service members were, in general, similar to those in the SEER population.

SIRs by occupational group for all leukemias for all men in 35 occupational groups are summarized in Table 4. The highest SIR compared with the entire DoD population was (SIR = 7.27, 95% CI = 0.88 to 26.26), based on 2 cases among service members who work mainly with wood. Their SIR compared to the SEER population was 5.30. Neither SIR was statistically significant. There is an apparent excess of total leukemia among ship mechanics (16 cases, DoD SIR = 1.68, 95% CI = 0.96 to 2.72), that approaches statistical significance and might warrant further surveillance in the future.

SIRs for lymphoid leukemia by occupational group are shown in Table 5. The highest SIRs were in printers (1 case, DoD SIR = 4.41, 95% CI = 0.11 to 24.55), textile workers (1 case, DoD SIR = 3.14, 95% CI = 0.08 to 17.49), physics laboratory workers (1 case, DoD SIR = 1.91, 95% CI = 0.05 to 10.65), and machinists (1 case, DoD SIR = 1.60, 95% CI = 0.04-8.92). Each of these SIRs was based on 1 case and was not statistically significant.

SIRs for myeloid leukemia by occupation are shown in Table 6. The highest SIR was for service members who work mainly with wood (as for all leukemias), although this was based on a single case (DoD SIR = 3.64, 95% CI = 0.09 to 20.26). SIRs were also suggestively high in equipment maintenance men (2 cases, DoD SIR = 1.20, 95% CI = 0.15 to 4.34), artillery operators (5 cases, DoD SIR = 0.95, 95% CI = 0.31 to 2.21), and radar operators (3 cases, DoD SIR = 0.95, 95% CI = 0.20, 2.78).

SIRs according to occupational group are shown in Tables 7 - 9 for white men. The findings in white men closely paralleled those in men of all races (Tables 4 - 6). None of the SIRs was statistically significant. Incidence rates of lymphoid, myeloid, and all leukemias in service members remained approximately constant during 1989 to 1999 (Table 10).

Discussion

This study had several strengths and limitations that are pertinent to the interpretation of the findings. The primary strengths of the study are the use of data obtained from standard inpatient data records completed by U.S. Department of Defense military treatment facilities throughout the world. The DoD uses a single data collection and coding system (ICD-9), and all active-duty service members are provided a uniform standard of care without charge in DoD medical treatment facilities.

Although comprehensive and standardized, use of data from DoD military treatment facilities suggests that some patients hospitalized in non-DoD facilities might be missed. It is unlikely that leukemia in active-duty service members would be treated to any important degree outside the DoD system. The data also are based solely on hospitalizations. This is not likely to be a serious limitation because it is unlikely that leukemia in an active-duty service member would be treated on an outpatient basis without at least an initial hospitalization.

Since leukemia is uncommon in the age range of most service members, the rates reported here are subject to a degree of random variability that is greater than that for more common diseases. This does not appear to have been a major problem, since rates observed in service members generally tended to be similar to rates in the SEER population. Every effort was made to assure that the hospitalizations counted in incidence rates were the first for leukemia. It is possible, although unlikely, that one or more of the cases may have been diagnosed before the time period of interest and such prior diagnosis may not have been evident. This could have resulted in a slight overestimation of incidence rates during the first year of the study.

This study was based solely on hospitalizations that occurred during active-duty service. After members leave military service, there is no centralized database of hospitalizations available to researchers that includes individual identifiers. As a result, it is not possible to determine incidence rates of leukemia after discharge from active-duty

service. Existing databases of community general hospital visits do not allow identification of individuals, and they provide only partial coverage of admissions to U.S. hospitals. Among these is the National Center for Health Statistics Hospital Discharge System, which samples hospital discharges on an anonymous basis and is not useful for medical follow-up, and the Professional Activity Study, which is also an anonymous database that cannot be used for medical follow-up.

Some retired service members may be hospitalized in Veterans Administration facilities, but such admissions are not available from the EI/DS data system that was used to perform this study. System administration would probably account for only a small proportion of hospital admissions of individuals who were discharged from military service, due to overlapping coverage from health insurance plans. Further research using a lifetime medical follow-up system to track military personnel after separation from service would be highly desirable. Such a system is being implemented at the Naval Health Research Center in San Diego, CA. It is known as the Millennium Cohort Study and will attempt to track the post service medical status of 120 000 members from the 4 DoD services using mailed questionnaires and the Internet. In the meantime, studies based on diagnosis during active-duty service, such as this study, may underestimate the differential risks associated with a particular occupation or the lifetime risk associated with being a service member. It is possible that longer follow-up would result in emergence of associations that were not present in this study, or that were present at a level that was below the criteria for statistical significance.

Occupational assignment is a rough surrogate for any specific exposures that might be causally related to leukemia. The 35 occupational categories used in this study were grouped based on job description. These categories may not correspond precisely with known or unknown occupational exposures that may have an etiologic significance. A detailed listing of 232 occupations comprising the 35 occupational categories used in this study is provided in Appendix Table A.

As previously noted, hospitalizations of active-duty service members in military medical treatment facilities are reported to the EI/DS, except for cases treated in wartime portable field hospitals or emergency medical facilities located aboard ships. Diagnosis of leukemia would be extremely rare in such facilities, which are mainly devoted to emergency care of traumatic injuries. If suspicion of leukemia occurred in a patient treated in one of these emergency settings, the individual would be evacuated to a permanent medical facility. As a result, he/she would have been included in this study. A review of computerized abstracts of medical records from such emergency facilities during a 6-month period in 1989, when reporting of cases from these facilities was mandatory, revealed no diagnoses of leukemia.

Conclusions

Overall, age-adjusted incidence rates of leukemia were slightly lower in the active-duty population than in the U.S. population. This finding was also true for lymphoid and myeloid leukemia separately. Incidence rates of leukemia rose exponentially with age in white men through ages 55 to 59, as in the SEER population. No cases were diagnosed among black men over ages 45 to 49, or among those of other races over ages 40 to 44. The age-adjusted incidence rate of leukemia in active-duty service members remained constant during 1989 to 1999.

Although this study provides little indication of an occupational etiology that resulted in a first hospitalization while on active-duty, the suggestive findings of this study should serve as a basis for further inquiry, such as medical follow-up of service members after separation, and occupational incidence studies in other populations. Non-statistically significantly elevated SIRs for all leukemia among woodworkers (2 cases, DoD SIR = 7.27, 95% CI = 0.88-26.26), construction workers (8 cases, DoD SIR = 1.34, 95% CI = 0.58-2.64), and radar operators (6 cases, DoD SIR = 1.90, 95% CI = 0.70-4.15) might warrant further surveillance of these groups in the future.

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Table 1. Leukemia (ICD9 Codes 204 - 208) incidence (first hospitalization) rates per 100,000 person-years, by age and race, active-duty men, Department of Defense, 1 January 1989 - 31 December 1999

MEN, All Races

Age	No. of Cases	No. of Person-Years	Dept. of Defense Rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER Rate†	Expected No. of Cases
15 - 19	7	671,448	1.0	0.4	2.1	2.7	18
20 - 24	96	5,252,427	1.8	1.5	2.2	2.6	137
25 - 29	56	3,683,680	1.5	1.2	2.0	2.6	96
30 - 34	57	2,799,588	2.0	1.6	2.7	3.3	92
35 - 39	59	2,234,535	2.6	2.0	3.4	4.2	94
40 - 44	43	1,138,377	3.8	2.7	5.0	5.6	64
45 - 49	23	380,336	6.0	3.8	9.1	8.3	32
50 - 54	8	85,687	9.3	4.0	18.4	14.4	12
55 - 59	4	13,844	28.9	7.9	74.0	20.6	3
60 - 64	0	2,933	0.0	0.0	102.3	32.4	1.0
Total	353	16,262,855	2.2	2.0	2.4	4.9	548

Standardized Incidence Ratio = 0.64 (95% Confidence Interval 0.58 - 0.72)‡

MEN, White

Age	No. of Cases	No. of Person-Years	Dept. of Defense rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER rate†	Expected No. of Cases
15 - 19	6	510,480	1.2	0.4	2.6	2.9	15
20 - 24	68	3,951,000	1.7	1.3	2.2	2.7	107
25 - 29	33	2,701,818	1.2	0.8	1.7	2.5	68
30 - 34	40	2,022,091	2.0	1.4	2.7	3.4	69
35 - 39	38	1,621,519	2.3	1.7	3.2	4.1	66
40 - 44	34	857,939	4.0	2.7	5.5	5.6	48
45 - 49	18	310,142	5.8	3.4	9.2	8.5	26
50 - 54	8	73,637	10.9	4.7	21.4	14.9	11
55 - 59	4	12,154	32.9	9.0	84.3	21.2	3
60 - 64	0	2,520	0.0	0.0	119.0	33.7	0.8
Total	249	12,063,300	2.1	1.8	2.3	4.9	413

Standardized Incidence Ratio = 0.60 (95% Confidence Interval 0.53 - 0.68)‡

MEN, Black		No. of	Dept. of	95% Confidence			Expected
	No. of	Person-	Defense	Interval*		U.S. SEER	No. of
Age	Cases	Years	rate	Lower	Upper	rate†	Cases
15 - 19	1	115,638	0.9	0.0	4.8	1.5	2
20 - 24	19	943,123	2.0	1.2	3.1	1.8	17
25 - 29	19	730,311	2.6	1.6	4.1	2.9	21
30 - 34	14	576,443	2.4	1.3	4.1	2.9	17
35 - 39	15	446,291	3.4	1.9	5.5	4.7	21
40 - 44	5	189,758	2.6	0.9	6.1	5.7	11
45 - 49	5	43,836	11.4	3.7	26.6	7.6	3
50 - 54	0	6,911	0.0	0.0	43.4	13.6	1
55 - 59	0	650	0.0	0.0	461.5	17.4	0
60 - 64	0	81	0.0	0.0	3703.7	25.8	0.0
Total	78	3,053,042	2.6	2.0	3.2	5.2	93

Standardized Incidence Ratio = 0.84 (95% Confidence Interval 0.67 - 1.05)‡

MEN, Other		No. of	Dept. of	95% Confidence			Expected
	No. of	Person-	Defense	Interval*		U.S. SEER	No. of
Age	Cases	Years	rate	Lower	Upper	rate†	Cases
15 - 19	0	45,330	0.0	0.0	6.6	2.9	1
20 - 24	9	358,304	2.5	1.2	4.8	2.9	10
25 - 29	4	251,551	1.6	0.4	4.1	3.0	8
30 - 34	3	201,054	1.5	0.3	4.4	3.0	6
35 - 39	6	166,725	3.6	1.3	7.8	3.7	6
40 - 44	4	90,680	4.4	1.2	11.3	4.5	4
45 - 49	0	26,358	0.0	0.0	11.4	5.3	1
50 - 54	0	5,139	0.0	0.0	58.4	5.8	0
55 - 59	0	1,040	0.0	1.0	288.5	13.6	0
60 - 64	0	332	0.0	2.0	903.6	19.8	0.1
Total	26	1,146,513	2.3	1.5	3.3	4.1	37

Standardized Incidence Ratio = 0.69 (95% Confidence Interval 0.45 - 1.02)‡

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

†National Cancer Institute, SEER Public Use Dataset, 1989-1998.

‡Calculated by applying age-specific rates from the SEER population for men of the same raceto the age distribution of the DoD population in the racial group.

Table 2. Lymphoid leukemia (ICD9 Code 204) incidence (first hospitalization) rates, by age and race, active-duty men, Department of Defense, 1 January 1989 - 31 December 1999

MEN, All Races

Age	No. of Cases	No. of Person-Years	Dept. of Defense rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER rate†	Expected No. of Cases
15 - 19	4	671,448	0.6	0.2	1.5	1.6	11
20 - 24	38	5,252,427	0.7	0.5	1.0	1.0	53
25 - 29	16	3,683,680	0.4	0.2	0.7	0.7	26
30 - 34	13	2,799,588	0.5	0.2	0.8	0.7	20
35 - 39	21	2,234,535	0.9	0.6	1.4	1.0	22
40 - 44	15	1,138,377	1.3	0.7	2.2	1.6	18
45 - 49	10	380,336	2.6	1.3	4.8	3.1	12
50 - 54	4	85,687	4.7	1.3	12.0	6.5	6
55 - 59	2	13,844	14.4	1.7	52.2	10.1	1
60 - 64	0	2,933	0.0	0.0	102.3	15.2	0.4
Total	123	16,262,855	0.8	0.6	0.9	1.6	168

Standardized Incidence Ratio = 0.73 (95% Confidence Interval 0.61 - 0.87)‡

MEN, White Age	No. of Cases	No. of Person-Years	Dept. of Defense rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER rate†	Expected No. of Cases
15 - 19	3	510,480	0.6	0.1	1.7	1.8	9
20 - 24	33	3,951,000	0.8	0.6	1.2	1.2	47
25 - 29	11	2,701,818	0.4	0.2	0.7	0.7	19
30 - 34	8	2,022,091	0.4	0.2	0.8	0.8	16
35 - 39	15	1,621,519	0.9	0.5	1.5	0.9	15
40 - 44	14	857,939	1.6	0.9	2.7	1.6	14
45 - 49	9	310,142	2.9	1.3	5.5	3.3	10
50 - 54	4	73,637	5.4	1.5	6.8	6.6	5
55 - 59	2	12,154	16.5	2.0	59.4	10.5	1
60 - 64	0	2,520	0.0	0.0	119.0	16.3	0.4
Total	99	12,063,300	0.8	0.7	1.0	1.7	137

Standardized Incidence Ratio = 0.72 (95% Confidence Interval 0.59 - 0.88)‡

MEN, Black	No. of	Dept. of	95% Confidence		Expected

Age	No. of Cases	Person-Years	Defense rate	Interval* Lower	Interval* Upper	U.S. SEER rate†	No. of Cases
15 - 19	1	115,638	0.9	0.0	4.8	0.7	1
20 - 24	1	943,123	0.1	0.0	0.6	0.5	5
25 - 29	5	730,311	0.7	0.2	1.6	0.6	4
30 - 34	4	576,443	0.7	0.2	1.8	0.7	4
35 - 39	5	446,291	1.1	0.4	2.6	1.1	5
40 - 44	1	189,758	0.5	0.0	2.9	1.5	3
45 - 49	1	43,836	2.3	0.1	12.7	2.7	1
50 - 54	0	6,911	0.0	0.0	43.4	5.9	0
55 - 59	0	650	0.0	0.0	461.5	10.0	0
60 - 64	0	81	0.0	0.0	3703.7	10.5	0.0
Total	18	3,053,042	0.6	0.3	0.9	1.3	23

Standardized Incidence Ratio = 0.77 (95% Confidence Interval 0.46 - 1.22)‡

MEN, Other

Age	No. of Cases	No. of Person-Years	Dept. of Defense rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER rate†	Expected No. of Cases
15 - 19	0	45,330	0.0	0.0	6.6	1.5	1
20 - 24	4	358,304	1.1	0.3	2.9	0.6	2
25 - 29	0	251,551	0.0	0.0	1.2	0.7	2
30 - 34	1	201,054	0.5	0.0	2.8	0.2	0
35 - 39	1	166,725	0.6	0.0	3.3	0.7	1
40 - 44	0	90,680	0.0	0.0	3.3	0.5	0
45 - 49	0	26,358	0.0	0.0	11.4	1.1	0
50 - 54	0	5,139	0.0	0.0	58.4	2.1	0
55 - 59	0	1,040	0.0	0.0	288.5	3.8	0
60 - 64	0	332	0.0	0.0	903.6	5.9	0.0
Total	6	1,146,513	0.5	0.2	1.1	0.9	7

Standardized Incidence Ratio = 0.85 (95% Confidence Interval 0.31 - 1.85)‡

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

†National Cancer Institute, SEER Public Use Dataset, 1989-1998.

‡Calculated by applying age-specific rates from the SEER population for men of the same raceto the age distribution of the DoD population in the racial group.

TABLE 3. Myeloid leukemia (ICD9 Code 205) incidence (first hospitalization) rates, by age and race, active-duty men, Department of Defense, 1 January 1989 - 31 December 1999

MEN, All Races

Age	No. of Cases	No. of Person-Years	Dept. of Defense rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER rate†
15 - 19	3	671,448	0.4	0.1	1.3	0.9
20 - 24	39	5,252,427	0.7	0.5	1.0	1.4
25 - 29	26	3,683,680	0.7	0.5	1.0	1.7
30 - 34	34	2,799,588	1.2	0.8	1.7	2.1
35 - 39	29	2,234,535	1.3	0.9	1.9	2.5
40 - 44	19	1,138,377	1.7	1.0	2.6	3.1
45 - 49	11	380,336	2.9	1.4	5.2	3.6
50 - 54	2	85,687	2.3	0.3	8.4	5.6
55 - 59	1	13,844	7.2	0.2	40.2	7.4
60 - 64	0	2,933	0.0	0.0	102.3	12.6
Total	164	16,262,855	1.0	0.9	1.2	2.8

Standardized Incidence Ratio = 0.53 (95% Confidence Interval 0.45 - 0.61)‡

MEN, White

Age	No. of Cases	No. of Person-Years	Dept. of Defense rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER rate†
15 - 19	3	510,480	0.6	0.1	1.7	0.9
20 - 24	27	3,951,000	0.7	0.5	1.0	1.3
25 - 29	14	2,701,818	0.5	0.3	0.9	1.5
30 - 34	23	2,022,091	1.1	0.7	1.7	2.0
35 - 39	19	1,621,519	1.2	0.7	1.8	2.4
40 - 44	13	857,939	1.5	0.8	2.6	3.0
45 - 49	7	310,142	2.3	0.9	4.6	3.5
50 - 54	2	73,637	2.7	0.3	9.8	5.8
55 - 59	1	12,154	8.2	0.2	45.8	7.4
60 - 64	0	2,520	0.0	0.0	119.0	12.7
Total	109	12,063,300	0.9	0.7	1.1	2.7

Standardized Incidence Ratio = 0.50 (95% Confidence Interval 0.41 - 0.61)‡

MEN, Black

		No. of	Dept. of	95% Confidence

Age	No. of Cases	Person-Years	Defense rate	Interval* Lower	Interval* Upper	U.S. SEER rate†
15 - 19	0	115,638	0.0	0.0	2.6	0.8
20 - 24	9	943,123	1.0	0.4	1.8	1.1
25 - 29	9	730,311	1.2	0.6	2.3	1.9
30 - 34	10	576,443	1.7	0.8	3.2	1.8
35 - 39	8	446,291	1.8	0.8	3.5	3.1
40 - 44	2	189,758	1.1	0.1	3.8	3.5
45 - 49	4	43,836	9.1	2.5	23.4	4.2
50 - 54	0	6,911	0.0	0.0	43.4	6.1
55 - 59	0	650	0.0	0.0	461.5	5.9
60 - 64	0	81	0.0	0.0	3703.7	11.1
Total	42	3,053,042	1.4	1.0	1.9	3.3

Standardized Incidence Ratio = 0.72 (95% Confidence Interval 0.52 - 0.97)‡

MEN, Other

Age	No. of Cases	No. of Person-Years	Dept. of Defense rate	95% Confidence Interval* Lower	95% Confidence Interval* Upper	U.S. SEER rate†
15 - 19	0	45,330	0.0	0.0	6.6	1.2
20 - 24	3	358,304	0.8	0.2	2.4	1.9
25 - 29	3	251,551	1.2	0.2	3.5	2.2
30 - 34	1	201,054	0.5	0.0	2.8	2.5
35 - 39	2	166,725	1.2	0.1	4.3	2.3
40 - 44	4	90,680	4.4	1.2	11.3	3.5
45 - 49	0	26,358	0.0	0.0	11.4	3.5
50 - 54	0	5,139	0.0	0.0	58.4	2.7
55 - 59	0	1,040	0.0	0.0	288.5	7.4
60 - 64	0	332	0.0	0.0	903.6	10.5
Total	13	1,146,513	1.1	0.6	1.9	2.6

Standardized Incidence Ratio = 0.50 (95% Confidence Interval 0.27 - 0.85)‡

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

†National Cancer Institute, SEER Public Use Dataset, 1989-1998.

‡Calculated by applying age-specific rates from the SEER population for men of the same raceto the age distribution of the DoD population in the racial group.

Table 4. Leukemia (ICD9 Codes 204 - 208) incidence (first hospitalization) rates and standardized incidence ratios (SIRs), by occupational category, active-duty Department of Defense men, 1989 - 1999

Occupational Category	No. of Cases	No. of Person-Years	Incidence rate	DoD SIR†	95% Confidence Interval*		SEER SIR‡	95% Confidence Interval*	
					Lower	Upper		Lower	Upper
WOODWORKING	2	15,671	12.76	7.27	0.88	26.26	5.30	0.64	19.13
PRINTING	1	10,616	9.42	4.41	0.11	24.55	3.31	0.08	18.45
TEXTILES	1	16,199	6.17	3.14	0.08	17.49	2.33	0.06	12.99
PHYSICS	1	19,891	5.03	1.91	0.05	10.65	1.48	0.04	8.23
RADAR	6	157,501	3.81	1.90	0.70	4.15	1.42	0.52	3.09
SHIP MECHANIC	16	465,979	3.43	1.68	0.96	2.72	1.26	0.72	2.04
MACHINIST	1	29,448	3.40	1.60	0.04	8.92	1.21	0.03	6.71
EDUCATION	12	339,754	3.53	1.49	0.77	2.60	1.14	0.59	1.99
CONSTRUCTION	8	283,175	2.83	1.34	0.58	2.64	1.01	0.43	1.99
MEDICAL	28	875,434	3.20	1.26	0.84	1.83	0.98	0.65	1.42
EQUIPMENT MAINTENANCE	2	82,678	2.42	1.20	0.15	4.34	0.90	0.11	3.23
LINE (SOLDIERS, SAILORS, AIRMEN)	47	1,879,345	2.50	1.15	0.84	1.53	0.86	0.63	1.15
COMMUNICATIONS	25	1,088,024	2.30	1.09	0.70	1.61	0.82	0.53	1.21
PILOT, HELICOPTERS	5	179,787	2.78	1.07	0.35	2.50	0.82	0.27	1.92
AVIATION MECHANIC	42	1,896,960	2.21	1.06	0.76	1.43	0.79	0.57	1.07
ARTILLERY	5	275,561	1.81	0.95	0.31	2.21	0.70	0.23	1.64
SERVICE	9	458,868	1.96	0.94	0.43	1.78	0.71	0.32	1.34
ELECTRONIC	16	848,699	1.89	0.92	0.52	1.48	0.69	0.39	1.11

TRANSPORT	7	368,087	1.90	0.91	0.37	1.88	0.68	0.27	1.41
GENERAL MECHANIC	16	913,614	1.75	0.88	0.51	1.43	0.66	0.38	1.07
NUCLEAR	3	182,099	1.65	0.88	0.18	2.56	0.65	0.13	1.89
PILOT, FIXED-WING	5	233,982	2.14	0.85	0.27	1.98	0.65	0.21	1.50
ADMINISTRATION	58	2,791,550	2.08	0.85	0.65	1.10	0.65	0.50	0.85
SUPPLY	11	611,971	1.80	0.79	0.39	1.42	0.60	0.30	1.07
ELECTRICAL	5	315,825	1.58	0.78	0.25	1.82	0.58	0.19	1.36
SAFETY	5	334,495	1.49	0.72	0.23	1.69	0.54	0.18	1.26
METAL MECHANIC	1	69,425	1.44	0.69	0.02	3.84	0.52	0.01	2.89
MISCELLANEOUS	9	843,245	1.07	0.67	0.31	1.28	0.45	0.20	0.85
AIRCREW	4	270,167	1.48	0.65	0.18	1.65	0.49	0.13	1.26
DECK	2	204,158	0.98	0.51	0.06	1.86	0.38	0.05	1.38
DIVERS	0	6,485	0.00	0.00	0.00	46.26	0.00	0.00	46.26
PETROLEUM	0	138,514	0.00	0.00	0.00	2.17	0.00	0.00	2.17
PILOT, GENERAL	0	780	0.00	0.00	0.00	384.62	0.00	0.00	384.62
VETERINARY	0	15,772	0.00	0.00	0.00	19.02	0.00	0.00	19.02
WELDING	0	39,096	0.00	0.00	0.00	7.67	0.00	0.00	7.67
TOTAL	353	16,262,855	2.17	-	-	-	-	-	-

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

† These SIRs were based on the total age-specific incidence rates for leukemia in all active-duty men who were Department of Defense service members during 1989-1999

‡ These SIRs were based on age-specific incidence rates from the National Cancer Institute SEER Public Use Dataset for 1989-1999.

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Table 5. Lymphoid leukemia (ICD9 Code 204) incidence (first hospitalization) rates and standardized incidence ratios (SIRs), by occupational category, active-duty Department of Defense men, 1989 - 1999

Occupational Category	No. of Cases	No. of Person-Years	Incidence Rate	DoD SIR†	95% Confidence Interval*		SEER SIR‡	95% Confidence Interval*	
					Lower	Upper		Lower	Upper
PRINTING	1	10,616	9.42	4.41	0.11	24.55	3.31	0.08	18.45
TEXTILES	1	16,199	6.17	3.14	0.08	17.49	2.33	0.06	12.99
PHYSICS	1	19,891	5.03	1.91	0.05	10.65	1.48	0.04	8.23
MACHINIST	1	29,448	3.40	1.60	0.04	8.92	1.21	0.03	6.71
PILOT, HELICOPTERS	4	179,787	2.22	0.86	0.23	2.20	0.66	0.18	1.69
CONSTRUCTION	4	283,175	1.41	0.67	0.18	1.72	0.50	0.14	1.29
NUCLEAR	2	182,099	1.10	0.59	0.07	2.11	0.43	0.05	1.56
SAFETY	4	334,495	1.20	0.58	0.16	1.48	0.43	0.12	1.11
LINE (SOLDIERS, SAILORS, AIRMEN)	19	1,879,345	1.01	0.46	0.28	0.72	0.35	0.21	0.55
ELECTRONIC	8	848,699	0.94	0.46	0.20	0.90	0.34	0.15	0.68
SHIP MECHANIC	4	465,979	0.86	0.42	0.11	1.08	0.31	0.09	0.81
COMMUNICATIONS	9	1,088,024	0.83	0.39	0.18	0.74	0.29	0.13	0.56
AVIATION MECHANIC	15	1,896,960	0.79	0.38	0.21	0.62	0.28	0.16	0.47
ADMINISTRATION	25	2,791,550	0.90	0.36	0.24	0.54	0.00	0.00	0.00
RADAR	1	157,501	0.63	0.32	0.01	1.77	0.24	0.01	1.32
ELECTRICAL	2	315,825	0.63	0.31	0.01	1.74	0.23	0.01	1.30
MISCELLANEOUS	4	843,245	0.47	0.30	0.08	0.77	0.20	0.05	0.51
EDUCATION	2	339,754	0.59	0.25	0.03	0.90	0.19	0.02	0.68
MEDICAL	5	875,434	0.57	0.22	0.07	0.52	0.18	0.06	0.41

GENERAL MECHANIC	4	913,614	0.44	0.22	0.06	0.57	0.16	0.04	0.42
SUPPLY	3	611,971	0.49	0.22	0.04	0.63	0.16	0.03	0.48
PILOT, FIXED-WING	1	233,982	0.43	0.17	0.00	0.95	0.13	0.00	0.72
AIRCREW	1	270,167	0.37	0.16	0.00	0.90	0.12	0.00	0.68
TRANSPORT	1	368,087	0.27	0.13	0.00	0.72	0.10	0.00	0.54
SERVICE	1	458,868	0.22	0.10	0.00	0.65	0.08	0.00	0.65
ARTILLERY	0	275,561	0.00	0.00	0.00	1.09	0.00	0.00	1.09
DECK	0	204,158	0.00	0.00	0.00	1.47	0.00	0.00	1.47
DIVERS	0	6,485	0.00	0.00	0.00	46.26	0.00	0.00	46.26
EQUIPMENT MAINTENANCE	0	82,678	0.00	0.00	0.00	3.63	0.00	0.00	3.63
METAL MECHANIC	0	69,425	0.00	0.00	0.00	4.32	0.00	0.00	4.32
PETROLEUM	0	138,514	0.00	0.00	0.00	2.17	0.00	0.00	2.17
PILOT, GENERAL	0	780	0.00	0.00	0.00	384.62	0.00	0.00	384.62
VETERINARY	0	15,772	0.00	0.00	0.00	19.02	0.00	0.00	19.02
WELDING	0	39,096	0.00	0.00	0.00	7.67	0.00	0.00	7.67
WOODWORKING	0	15,671	0.00	0.00	0.00	19.14	0.00	0.00	19.14
TOTAL	123	16,262,855	0.76	-	-	-	-	-	-

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

† These SIRs were based on the total age-specific incidence rates for leukemia in all active-duty men who were Department of Defense service members during 1989-1999

‡ These SIRs were based on age-specific incidence rates from the National Cancer Institute SEER Public Use Dataset for 1989-1999.

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Table 6. Myeloid leukemia (ICD9 Code 205) incidence (first hospitalization) rates and standardized incidence ratios (SIRs) by occupational category, active-duty Department of Defense men, 1989 - 1999

Occupational Category	No. of Cases	No. of Person-Years	Incidence Rate	DoD SIR†	95% Confidence Interval*		SEER SIR‡	95% Confidence Interval*	
					Lower	Upper		Lower	Upper
WOODWORKING	1	15,671	6.38	3.64	0.09	20.26	2.65	0.07	14.76
EQUIPMENT MAINTENANCE	2	82,678	2.42	1.20	0.15	4.34	0.90	0.11	3.23
RADAR	3	157,501	1.90	0.95	0.20	2.78	0.71	0.15	2.07
ARTILLERY	5	275,561	1.81	0.95	0.31	2.21	0.70	0.23	1.64
SHIP MECHANIC	9	465,979	1.93	0.95	0.44	1.80	0.71	0.33	1.35
MEDICAL	20	875,434	2.28	0.90	0.55	1.39	0.70	0.43	1.08
EDUCATION	7	339,754	2.06	0.87	0.35	1.79	0.66	0.27	1.37
CONSTRUCTION	4	283,175	1.41	0.67	0.18	1.72	0.50	0.14	1.29
COMMUNICATIONS	12	1,088,024	1.10	0.52	0.27	0.91	0.39	0.20	0.69
TRANSPORT	4	368,087	1.09	0.52	0.14	1.33	0.39	0.11	1.00
DECK	2	204,158	0.98	0.51	0.06	1.86	0.38	0.05	1.38
PILOT, FIXED-WING	3	233,982	1.28	0.51	0.10	1.49	0.39	0.08	1.13
SUPPLY	7	611,971	1.14	0.50	0.20	1.04	0.38	0.15	0.79
AIRCREW	3	270,167	1.11	0.48	0.10	1.41	0.37	0.08	1.08
AVIATION MECHANIC	19	1,896,960	1.00	0.48	0.29	0.75	0.36	0.22	0.56
ELECTRICAL	3	315,825	0.95	0.47	0.10	1.37	0.35	0.07	1.02
SERVICE	4	458,868	0.87	0.42	0.01	2.32	0.31	0.01	1.75
ELECTRONIC	7	848,699	0.82	0.40	0.16	0.83	0.30	0.12	0.62

GENERAL MECHANIC	7	913,614	0.77	0.39	0.15	0.80	0.29	0.12	0.59
MISCELLANEOUS	5	843,245	0.59	0.37	0.12	0.87	0.25	0.08	0.58
LINE (SOLDIERS, SAILORS, AIRMEN)	15	1,879,345	0.80	0.37	0.20	0.60	0.28	0.15	0.46
ADMINISTRATION	20	2,791,550	0.72	0.29	0.18	0.45	0.23	0.14	0.35
PILOT, HELICOPTERS	1	179,787	0.56	0.21	0.01	1.20	0.16	0.00	0.92
SAFETY	1	334,495	0.30	0.14	0.00	0.81	0.11	0.00	0.60
DIVERS	0	6,485	0.00	0.00	0.00	46.26	0.00	0.00	46.26
MACHINIST	0	29,448	0.00	0.00	0.00	10.19	0.00	0.00	10.19
METAL MECHANIC	0	69,425	0.00	0.00	0.00	4.32	0.00	0.00	4.32
NUCLEAR	0	182,099	0.00	0.00	0.00	1.65	0.00	0.00	1.65
PETROLEUM	0	138,514	0.00	0.00	0.00	2.17	0.00	0.00	2.17
PHYSICS	0	19,891	0.00	0.00	0.00	15.08	0.00	0.00	15.08
PILOT, GENERAL	0	780	0.00	0.00	0.00	384.62	0.00	0.00	384.62
PRINTING	0	10,616	0.00	0.00	0.00	28.26	0.00	0.00	28.26
TEXTILES	0	16,199	0.00	0.00	0.00	18.52	0.00	0.00	18.52
VETERINARY	0	15,772	0.00	0.00	0.00	19.02	0.00	0.00	19.02
WELDING	0	39,096	0.00	0.00	0.00	7.67	0.00	0.00	7.67
TOTAL	164	16,262,855	1.01	-	-	-	-	-	-

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

† These SIRs were based on the total age-specific incidence rates for leukemia in all active-duty men who were Department of Defense service members during 1989-1999

‡ These SIRs were based on age-specific incidence rates from the National Cancer Institute SEER Public Use Dataset for 1989-1999.

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Table 7. Leukemia (ICD9 Codes 204 - 208) incidence (first hospitalization) rates and standardized incidence ratios (SIRs), by occupational category, active-duty Department of Defense white men, 1989 - 1999

Occupational Category	No. of Cases	No. of Person-Years	Incidence Rate	DoD SIR†	95% Confidence Interval*		SEER SIR‡	95% Confidence Interval*	
					Lower	Upper		Lower	Upper
TEXTILES	1	11,384	8.78	4.90	0.12	27.27	3.34	0.08	18.63
PHYSICS	1	17,473	5.72	2.25	0.06	12.52	1.66	0.04	9.25
CONSTRUCTION	8	225,567	3.55	1.80	0.77	3.54	1.26	0.54	2.49
RADAR	4	118,907	3.36	1.79	0.49	4.59	1.24	0.34	3.18
EDUCATION	8	243,124	3.29	1.54	0.66	3.03	1.09	0.47	2.15
SHIP MECHANIC	10	342,139	2.92	1.54	0.74	2.83	1.07	0.52	1.98
ARTILLERY	4	153,363	2.61	1.47	0.40	3.77	1.01	0.28	2.60
TRANSPORT	6	239,342	2.51	1.27	0.47	2.77	0.90	0.33	1.95
COMMUNICATIONS	19	783,752	2.42	1.21	0.73	1.89	0.85	0.51	1.33
PILOT, HELICOPTERS	5	168,076	2.97	1.20	0.39	2.79	0.88	0.28	2.05
LINE (SOLDIERS, SAILORS, AIRMEN)	35	1,444,871	2.42	1.18	0.82	1.63	0.84	0.58	1.16
GENERAL MECHANIC	13	663,297	1.96	1.08	0.57	1.84	0.74	0.40	1.27
NUCLEAR	3	170,548	1.76	1.03	0.21	3.00	0.69	0.14	2.01
ELECTRICAL	4	210,112	1.90	1.02	0.28	2.60	0.71	0.19	1.81
MEDICAL	16	629,625	2.54	1.00	0.57	1.62	0.76	0.43	1.23
SAFETY	5	263,595	1.90	0.99	0.32	2.32	0.69	0.22	1.61
AVIATION MECHANIC	28	1,500,075	1.87	0.96	0.64	1.40	0.67	0.45	0.98
SUPPLY	7	338,561	2.07	0.94	0.38	1.94	0.68	0.27	1.39

METAL MECHANIC	1	54,580	1.83	0.94	0.02	5.24	0.66	0.02	3.68
PILOT, FIXED-WING	5	226,029	2.21	0.92	0.30	2.15	0.67	0.22	1.55
ADMINISTRATION	42	2,049,292	2.05	0.84	0.61	1.14	0.63	0.45	0.85
EQUIPMENT MAINTENANCE	1	64,025	1.56	0.84	0.02	4.68	0.58	0.01	3.23
ELECTRONIC	11	718,577	1.53	0.80	0.40	1.43	0.56	0.28	0.99
MISCELLANEOUS	6	642,331	0.93	0.61	0.22	1.32	0.39	0.14	0.85
AIRCREW	3	237,742	1.26	0.58	0.12	1.68	0.41	0.09	1.21
SERVICE	2	231,513	0.86	0.45	0.06	1.64	0.32	0.04	1.14
DECK	1	140,740	0.71	0.40	0.01	2.22	0.28	0.01	1.53
DIVERS	0	6,148	0.00	0.00	0.00	48.80	0.00	0.00	48.80
MACHINIST	0	22,465	0.00	0.00	0.00	13.35	0.00	0.00	13.35
PETROLEUM	0	85,033	0.00	0.00	0.00	3.53	0.00	0.00	3.53
PILOT, GENERAL	0	762	0.00	0.00	0.00	393.70	0.00	0.00	393.70
PRINTING	0	6,220	0.00	0.00	0.00	48.23	0.00	0.00	48.23
VETERINARY	0	11,582	0.00	0.00	0.00	25.90	0.00	0.00	25.90
WELDING	0	32,298	0.00	0.00	0.00	9.29	0.00	0.00	9.29
WOODWORKING	0	10,152	0.00	0.00	0.00	29.55	0.00	0.00	29.55
TOTAL	249	12,063,300	2.06	-	-	-	-	-	-

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

† These SIRs were based on the total age-specific incidence rates for leukemia in all active-duty men who were Department of Defense service members during 1989-1999

‡ These SIRs were based on age-specific incidence rates from the National Cancer Institute SEER Public Use Dataset for 1989-1999.

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Table 8. Lymphoid leukemia (ICD9 Code 204) incidence (first hospitalization) rates and standardized incidence ratios (SIRs), by occupational category, active-duty Department of Defense white men, 1989 - 1999

Occupational Category	No. of Cases	No. of Person-Years	Incidence Rate	DoD SIR†	95% Confidence Interval*		SEER SIR‡	95% Confidence Interval*	
					Lower	Upper		Lower	Upper
TEXTILES	1	11,384	8.78	4.90	0.12	27.27	3.34	0.08	18.63
PHYSICS	1	17,473	5.72	2.25	0.06	12.52	1.66	0.04	9.25
PILOT, HELICOPTERS	4	168,076	2.38	0.96	0.26	2.46	0.70	0.19	1.80
CONSTRUCTION	4	225,567	1.77	0.90	0.24	2.30	0.63	0.17	1.62
SAFETY	4	263,595	1.52	0.80	0.22	2.04	0.55	0.15	1.41
NUCLEAR	2	170,548	1.17	0.68	0.08	2.47	0.46	0.06	1.66
LINE (SOLDIERS, SAILORS, AIRMEN)	16	1,444,871	1.11	0.54	0.31	0.87	0.38	0.22	0.62
COMMUNICATIONS	7	783,752	0.89	0.45	0.18	0.92	0.31	0.13	0.65
ADMINISTRATION	21	2,049,292	1.02	0.42	0.26	0.65	0.31	0.19	0.48
AVIATION MECHANIC	12	1,500,075	0.80	0.41	0.21	0.72	0.29	0.15	0.50
MISCELLANEOUS	4	642,331	0.62	0.40	0.11	1.03	0.26	0.07	0.67
SUPPLY	3	338,561	0.89	0.40	0.08	0.69	0.29	0.06	0.50
EDUCATION	2	243,124	0.82	0.38	0.05	1.39	0.27	0.03	0.98
ELECTRONIC	5	718,577	0.70	0.36	0.12	0.85	0.25	0.08	0.59
MEDICAL	5	629,625	0.79	0.31	0.10	0.73	0.24	0.08	0.55
SHIP MECHANIC	2	342,139	0.58	0.31	0.04	1.11	0.21	0.03	0.78
ELECTRICAL	1	210,112	0.48	0.25	0.01	1.42	0.18	0.00	0.98
GENERAL MECHANIC	3	663,297	0.45	0.25	0.05	0.43	0.17	0.04	0.29

TRANSPORT	1	239,342	0.42	0.21	0.01	1.18	0.15	0.00	0.83
PILOT, FIXED-WING	1	226,029	0.44	0.18	0.00	1.03	0.13	0.00	0.74
AIRCREW	0	237,742	0.00	0.00	0.00	1.26	0.00	0.00	1.26
ARTILLERY	0	153,363	0.00	0.00	0.00	1.96	0.00	0.00	1.96
DECK	0	140,740	0.00	0.00	0.00	2.13	0.00	0.00	2.13
DIVERS	0	6,148	0.00	0.00	0.00	48.80	0.00	0.00	48.80
EQUIPMENT MAINTENANCE	0	64,025	0.00	0.00	0.00	4.69	0.00	0.00	4.69
MACHINIST	0	22,465	0.00	0.00	0.00	13.35	0.00	0.00	13.35
METAL MECHANIC	0	54,580	0.00	0.00	0.00	5.50	0.00	0.00	5.50
PETROLEUM	0	85,033	0.00	0.00	0.00	3.53	0.00	0.00	3.53
PILOT, GENERAL	0	762	0.00	0.00	0.00	393.70	0.00	0.00	393.70
PRINTING	0	6,220	0.00	0.00	0.00	48.23	0.00	0.00	48.23
RADAR	0	118,907	0.00	0.00	0.00	2.52	0.00	0.00	2.52
SERVICE	0	231,513	0.00	0.00	0.00	1.30	0.00	0.00	1.30
VETERINARY	0	11,582	0.00	0.00	0.00	25.90	0.00	0.00	25.90
WELDING	0	32,298	0.00	0.00	0.00	9.29	0.00	0.00	9.29
WOODWORKING	0	10,152	0.00	0.00	0.00	29.55	0.00	0.00	29.55
TOTAL	99	12,063,300	0.82	-	-	-	-	-	-

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

† These SIRs were based on the total age-specific incidence rates for leukemia in all active-duty men who were Department of Defense service members during 1989-1999

‡ These SIRs were based on age-specific incidence rates from the National Cancer Institute SEER Public Use Dataset for 1989-1999.

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Table 9. Myeloid leukemia (ICD9 Code 205) incidence (first hospitalization) rates and standardized incidence ratios (SIRs), by occupational category, active-duty Department of Defense white men, 1989 - 1999

Occupational Category	No. of Cases	No. of Person-Years	Incidence Rate	DoD SIR†	95% Confidence Interval*		SEER SIR‡	95% Confidence Interval*	
					Lower	Upper		Lower	Upper
ARTILLERY	4	153,363	2.61	1.47	0.40	3.77	1.73	0.47	4.42
RADAR	3	118,907	2.52	1.34	0.28	3.93	1.55	0.32	4.54
SHIP MECHANIC	7	342,139	2.05	1.07	0.43	2.22	1.27	0.51	2.61
EDUCATION	5	243,124	2.06	0.96	0.31	2.24	1.13	0.36	2.62
CONSTRUCTION	4	225,567	1.77	0.90	0.24	2.30	1.06	0.29	2.71
EQUIPMENT MAINTENANCE	1	64,025	1.56	0.84	0.02	4.68	0.96	0.02	5.37
ELECTRICAL	3	210,112	1.43	0.76	0.16	2.23	0.89	0.18	2.59
MEDICAL	11	629,625	1.75	0.69	0.34	1.23	0.89	0.45	1.60
TRANSPORT	3	239,342	1.25	0.64	0.13	1.86	0.76	0.16	2.20
AIRCREW	3	237,742	1.26	0.58	0.12	1.68	0.68	0.14	1.99
PILOT, FIXED-WING	3	226,029	1.33	0.55	0.11	1.61	0.66	0.14	1.92
SUPPLY	4	338,561	1.18	0.54	0.15	1.38	0.65	0.18	1.66
COMMUNICATIONS	8	783,752	1.02	0.51	0.22	1.00	0.60	0.26	1.19
GENERAL MECHANIC	5	663,297	0.75	0.41	0.13	0.97	0.48	0.15	1.11
DECK	1	140,740	0.71	0.40	0.01	2.22	0.47	0.01	2.62
AVIATION MECHANIC	11	1,500,075	0.73	0.38	0.19	0.68	0.44	0.22	0.78
ELECTRONIC	5	718,577	0.70	0.36	0.12	0.85	0.42	0.14	0.97

LINE (SOLDIERS, SAILORS, AIRMEN)	10	1,444,871	0.69	0.34	0.16	0.62	0.41	0.20	0.75
ADMINISTRATION	14	2,049,292	0.68	0.28	0.15	0.47	0.36	0.19	0.60
PILOT, HELICOPTERS	1	168,076	0.59	0.24	0.01	1.34	0.29	0.01	1.62
MISCELLANEOUS	2	642,331	0.31	0.20	0.02	0.73	0.25	0.03	0.90
SAFETY	1	263,595	0.38	0.20	0.01	1.11	0.23	0.01	1.28
DIVERS	0	6,148	0.00	0.00	0.00	48.80	0.00	0.00	48.80
MACHINIST	0	22,465	0.00	0.00	0.00	13.35	0.00	0.00	13.35
METAL MECHANIC	0	54,580	0.00	0.00	0.00	5.50	0.00	0.00	5.50
NUCLEAR	0	170,548	0.00	0.00	0.00	1.76	0.00	0.00	1.76
PETROLEUM	0	85,033	0.00	0.00	0.00	3.53	0.00	0.00	3.53
PHYSICS	0	17,473	0.00	0.00	0.00	17.17	0.00	0.00	17.17
PILOT, GENERAL	0	762	0.00	0.00	0.00	393.70	0.00	0.00	393.70
PRINTING	0	6,220	0.00	0.00	0.00	48.23	0.00	0.00	48.23
SERVICE	0	231,513	0.00	0.00	0.00	1.30	0.00	0.00	1.30
TEXTILES	0	11,384	0.00	0.00	0.00	26.35	0.00	0.00	26.35
VETERINARY	0	11,582	0.00	0.00	0.00	25.90	0.00	0.00	25.90
WELDING	0	32,298	0.00	0.00	0.00	9.29	0.00	0.00	9.29
WOODWORKING	0	10,152	0.00	0.00	0.00	29.55	0.00	0.00	29.55
TOTAL	109	12,063,300	0.90	-	-	-	-	-	-

* Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

† These SIRs were based on the total age-specific incidence rates for leukemia in all active-duty men who were Department of Defense service members during 1989-1999

‡ These SIRs were based on age-specific incidence rates from the National Cancer Institute SEER Public Use Dataset for 1989-1999.

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Table 10. Temporal trends in hospitalized incidence rates per 100,000 person-years and Standardized Incidence Ratios, leukemia, white men, Department of Defense, 1989-1999

A. All leukemia (ICD9 Codes 204-208)

Year	No. of cases	No. of person-years	DOD incidence rate	Standardized incidence ratio*	95% Confidence interval† Lower	Upper
1989	29	1,408,704	2.06	0.81	0.54	1.16
1990	39	1,353,267	2.88	0.95	0.67	1.30
1991	25	1,336,352	1.87	0.85	0.55	1.25
1992	29	1,222,256	2.37	0.71	0.48	1.03
1993	22	1,130,005	1.95	0.83	0.52	1.26
1994	24	1,068,223	2.25	0.78	0.50	1.16
1995	20	995,905	2.01	0.69	0.42	1.06
1996	18	937,715	1.92	0.90	0.53	1.42
1997	16	896,711	1.78	0.76	0.44	1.24
1998	17	871,817	1.95	0.82	0.48	1.31
1999	10	842,345	1.19	0.81	0.39	1.49
Total	249	12,063,300	2.06	0.79	0.69	0.89

B. Lymphoid leukemia (ICD9 Code 204)

1989	14	1,408,704	0.99	0.92	0.50	1.55
1990	17	1,353,267	1.26	1.24	0.72	1.98
1991	7	1,336,352	0.52	0.98	0.39	2.01
1992	6	1,222,256	0.49	1.00	0.37	2.19
1993	7	1,130,005	0.62	1.13	0.45	2.32
1994	13	1,068,223	1.22	1.13	0.60	1.93
1995	8	995,905	0.80	0.88	0.38	1.74
1996	4	937,715	0.43	1.16	0.31	2.96
1997	7	896,711	0.78	1.10	0.44	2.27
1998	11	871,817	1.26	1.08	0.54	1.93
1999	5	842,345	0.59	1.23	0.40	2.86
Total	99	12,063,300	0.82	0.89	0.72	1.08

C. Myeloid leukemia (ICD9 Code 205)

1989	13	1,408,704	0.97	0.81	0.43	1.38
1990	12	1,353,267	0.93	0.82	0.42	1.44
1991	12	1,336,352	0.93	0.74	0.38	1.30
1992	17	1,222,256	1.44	0.59	0.34	0.94
1993	13	1,130,005	1.19	0.65	0.35	1.11
1994	7	1,068,223	0.68	0.58	0.23	1.20
1995	10	995,905	1.03	0.61	0.29	1.12
1996	10	937,715	1.10	0.75	0.36	1.38
1997	8	896,711	0.92	0.62	0.27	1.22
1998	3	871,817	0.36	0.70	0.14	2.05
1999	4	842,345	0.49	0.60	0.16	1.53
Total	109	12,063,300	0.94	0.64	0.53	0.77

*SIRs were calculated using annual SEER age-specific rates for white men as the standard.
†Confidence limits were calculated using the Poisson distribution. Source: Lilienfeld DE, Stolley PD. Foundations of Epidemiology, 3rd ed. New York: Oxford, 1994:303.

Appendix A. List of 35 standard tri-service occupational categories for cancer research, Department of Defense, 1989-1999

Occupational category and occupations	[1]NHRC-DoD Occupation Category*
1. ADMINISTRATION	
ADMINISTRATION, GENERAL (001)	1
ADMINISTRATION, GENERAL (002)	2
AUTOMATED DATA PROCESSING COMPUTERS, GENERAL	82
AIR TRAFFIC CONTROL	44
ANALYSIS	83
AUDITING AND ACCOUNTING	3
AVIATION MAINTENANCE RECORDS AND REPORTS	37
CENTRAL OFFICE	4
CHAPLAINS	203
CHAPLAIN'S ASSISTANTS	202
COMBAT ENGINEERING, GENERAL	49
COMBINED PERSONNEL AND ADMINISTRATION, GENERAL	5
COMMUNITY ACTIVITIES OFFICERS	6
COMPTROLLERS AND FISCAL	7
COUNTERINTELLIGENCE	110
COUNTERINTELLIGENCE	111
DATA PROCESSING	84
DISBURSING	8
DRAFTING	170
ENGINEERING, OTHER	130
EXECUTIVES, N.E.C.	9
FUNCTIONAL ANALYSIS	11
HEALTH SERVICES ADMINISTRATION OFFICERS	147
ILLUSTRATING	164
IMAGE INTERPRETATION	54
INFORMATION	85
INFORMATION AND EDUCATION, GENERAL	95
INSPECTION	13
INTELLIGENCE, GENERAL	112
INVESTIGATIONS	115
LANGUAGE INTERROGATION/INTERPRETATION	14
LAW ENFORCEMENT, GENERAL	116
LEGAL (117)	117
LEGAL (118)	118

17. METALWORKER

18. MISCELLANEOUS OCCUPATION

19. NUCLEAR-RELATED OCCUPATIONS

20. PETROLEUM

21. PHYSICS

22. PILOT, FIXED WING AIRCRAFT

23. PILOT, UNSPECIFIED TYPE AIRCRAFT

24. PILOT, HELICOPTER

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13. SUPPLEMENTARY NOTES

14. ABSTRACT (maximum 200 words) This historical prospective study determined incidence rates, based on first hospitalizations, of lymphoid, myeloid, and all leukemias among military men serving on active duty between 1 January 1989 and 31 December 1999. Standardized incidence ratios (SIRs) were calculated to determine if incidence of leukemia in military men differed from incidence rates in the 9 area U.S. Surveillance, Epidemiology and End Results (SEER) civilian population. Military occupations were grouped into 35 categories according to likelihood of similar exposures, and age-specific person-years were calculated for each occupational group. There were a total of 16,262,855 person-years at risk in active-duty men over the 132-month study with $N = 353$ first hospitalizations for leukemia (ICD-9 Codes 204 - 208), including $N = 123$ for lymphoid leukemia (ICD-9 Code 204) and $N = 164$ for myeloid leukemia (ICD-9 Code 205). Overall, leukemia incidence rates were significantly lower in the active-duty population in comparison with the SEER population (SIR = 0.64, 95% CI, 0.58 to 0.68). This was true for both lymphoid (SIR = 0.73, 95% CI, 0.61 to 0.87) and myeloid (SIR = 0.53, 95% CI, 0.45 to 0.61) leukemia. SIRs based on SEER and the Department of Defense (DoD) standard populations revealed no occupational group at statistically significantly elevated risk for lymphoid, myeloid, or all leukemias. Elevated SIRs for all leukemias that did not achieve statistical significance were observed for ship mechanics (16 cases, DoD SIR = 1.68, 95% CI, 0.96 to 2.72), woodworkers (2 cases, DoD SIR = 7.27, 95% CI, 0.88 to 26.26), construction workers (8 cases, DoD SIR = 1.34, 95% CI, 0.58 to 2.64), and radar operators (6 cases, DoD SIR = 1.90, 95% CI, 0.70 to 4.15).

15. SUBJECT TERMS
Leukemia, occupational studies, military populations, cancer, epidemiology

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